

CUP Diagnostics and IBM's Health Checker for z/OS

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Agenda

- FICON CUP brief history and functional review
- Traditional FICON CUP uses
- FICON CUP Diagnostics and reporting
- IBM Health Checker for z/OS

FICON CUP Brief History and Functional Review



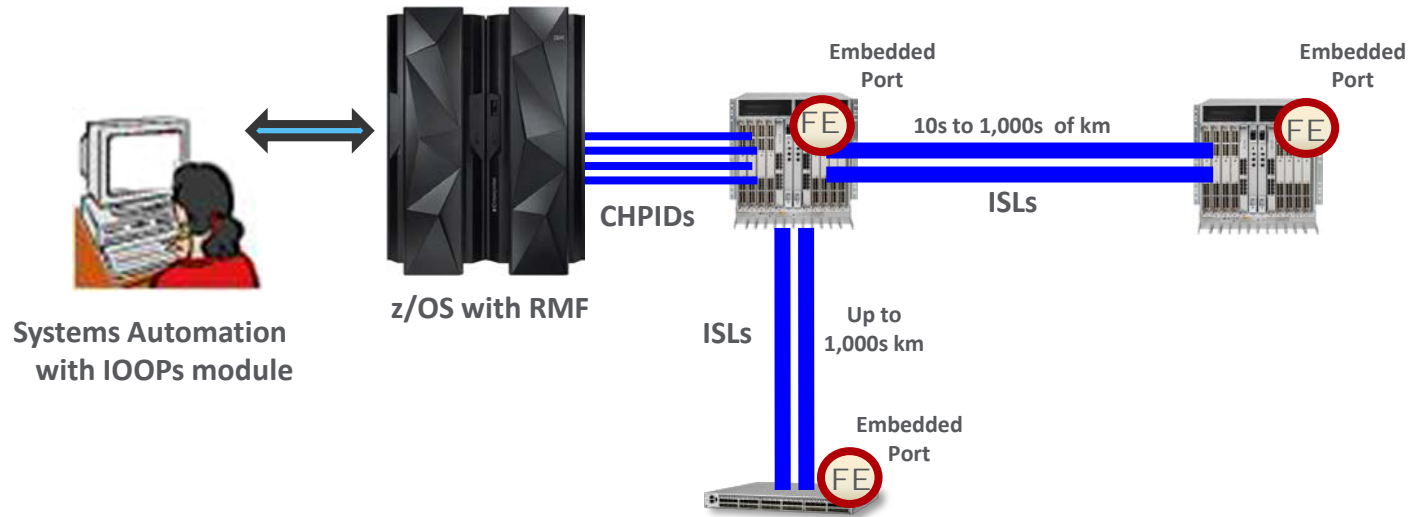
Control Unit Port-CUP

- CUP on FICON is a legacy of CUP on ESCON
- The 9032-5 ESCON Directors had an in-band management capability that utilized an embedded port in the control processing cards to provide a communications path to an MVS console
 - Reporting hardware errors up to MVS (Helpdesk)
 - Blocking and unblocking ports through the Prohibit Dynamic Connectivity Mask (PDCMs)
 - Basic performance monitoring
- When switched-FICON was being engineered, IBM wanted to be sure that its users would have a consistent look and feel between ESCON and FICON including CUP

FICON CUP

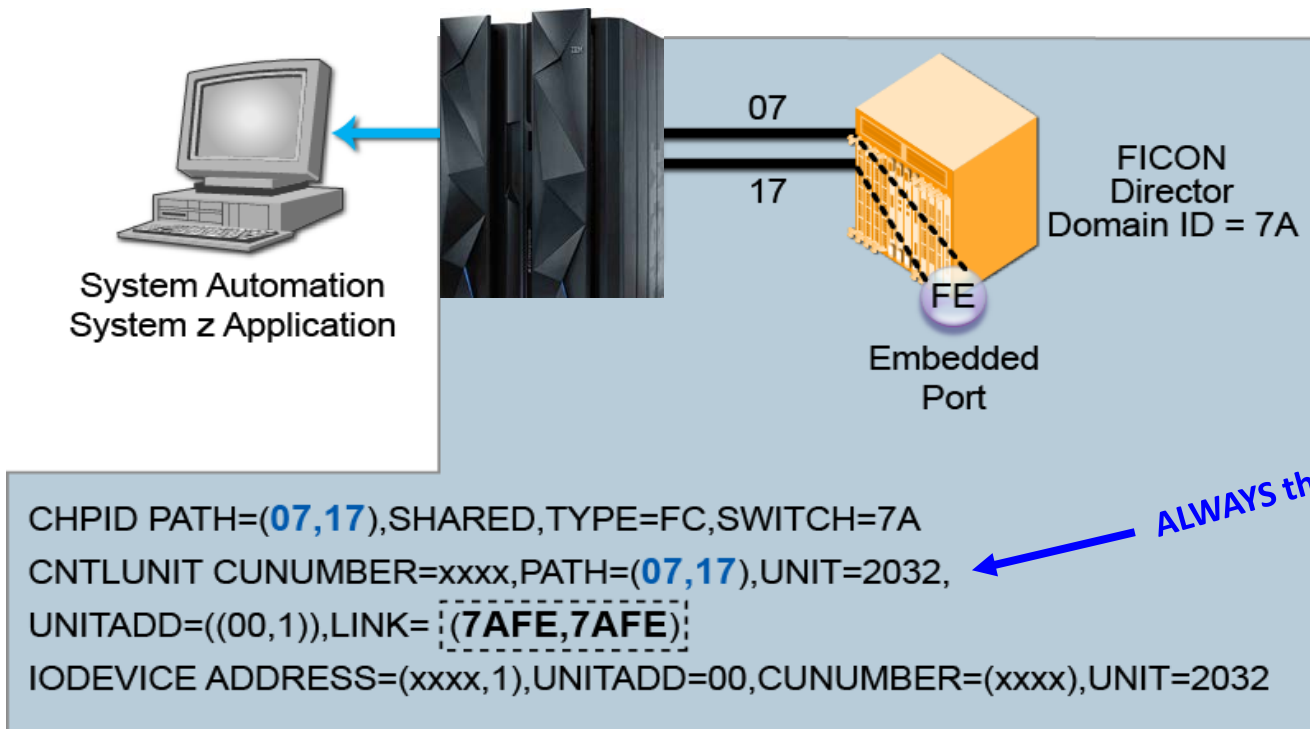
- CUP = Control Unit Port (an embedded not physical port)
 - “FE”
 - Allows in-band management of Directors from the management applications on a Mainframe
 - Used for configuration, monitoring, and error handling
- CUP support is provided by all z Systems qualified FICON SAN vendors
 - Usually it is an optional licensed feature
 - Supported in single or cascaded FICON environments
- FICON CUP is typically used by customers with:
 - SA/zOS (System Automation software)
 - RMF (Resource Measurement Facility)

CUP for RMF and Systems Automation



- This is a simplified representation of an FICON environment and how CUP might fit into that environment.
- Best practice is to have two CHPIDS with access to each CUP
- FICON Cascading requires implementing, high integrity, safe switching fabrics.
- Safe switching describes the System Automation process of path removal. Simply stated, safe switching is a process that involves contacting all systems in a sysplex and verifying a path can be removed before it is actually removed.¹

Defining CUP in HCD



The CUP address is always FE

Traditional FICON CUP Uses



In Band Management

- Host based management programs such as System Automation for z/OS through CUP can manage the FICON switching devices.
 - Commands sent to the switch CU defined in IOCDS and HCD.
 - 42 CUP commands (CCWs) defined in the FICON Director Programming Interface for monitoring and controlling FICON switch functions.
 - Blocking/unblocking and port prohibits

Error Reporting

- It is usually important to get the Service Information Messages (SIM) to the MVS operator consoles for FICON device hardware failures.
- CUP provides the mechanism for FICON switch related hardware errors to be reported to z/OS against a device number.
 - If the switch is not defined as an I/O device through the use of CUP, and/or that I/O device is not online to z/OS, then switch related errors cannot be surfaced up to z/OS so that it can take appropriate actions

Performance Management and Monitoring

- FICON Dynamic Channel Path Management (FICON DCM) requires CUP.
- Port Decommissioning feature on the FICON switching devices requires CUP.
- RMF reporting on FICON switching devices (RMF 74-7 record) requires CUP.

FICON Director Activity Report (RMF 74-7 Record)

- The FICON Director Activity Report captures information about a Domain ID based on an interval which is set for RMF.
- In essence, the report captures a snapshot of data and the counters based on a time interval, such as 20 minutes.
- This RMF report is often overlooked but contains very meaningful data concerning FICON I/O performance - in particular, frame pacing delay
- Frame pacing delay, only captured when CUP is active on a switch, is a fabric-wide method that z/OS management capabilities can use to indicate a port's BB_Credit starvation potential issues

FICON CUP Diagnostics and Reporting





Brocade CUP Diagnostics

Identify routing issues and transceiver health

- CUP Diagnostics, provides z Systems with visibility into fabric events that the z/OS operating system has historically not been aware of in the past.
- Complex configurations can result in FICON fabric issues that provide unacceptable I/O service times to application users:
 - RMF might show average service times higher than normal and matching I/O queuing reports show abnormally high “initial command response” times
 - Before the CUP Diagnostic enhancements, it was very problematic to identify a single root cause for these issues or where in the fabric a problem might have originated



Brocade CUP Diagnostics

Identify routing issues and transceiver health

- Currently there are two distinct capabilities:
- The use of CUP Diagnostics by the z/OS Display Matrix command to see frame routing and SFP health data (FOS 7.1)
- The use of CUP Diagnostics through triggered MAPS events (FOS 7.4).
 - MAPS can proactively notify z Systems about abnormal conditions in the fabric that may impact either performance or reliability of the I/O traffic traversing through the fabric

Switch (CUP) Diagnostics – APAR

- [OA40548](#)
 - NEW FUNCTION APAR TO SUPPORT THE SWITCH CUP DIAGNOSTICS FUNCTION
- New keywords
 - ROUTE and HEALTH have been added to the D M=DEV command which will allow the route through the fabric to be displayed in response to the command being issued
- Two new z/OS IBM Health Checks
 - IBMIOS, [IOS FABRIC MONITOR](#) and IBMIOS, [IOS IORATE MONITOR](#) have been added to recognize certain problems within the fabric

D M=DEV – Support for ROUTE / HEALTH

- z/OS MVS System Commands (SA22-7627)
- D M={DEVICE | DEV}(/ devnum,(chp))
 - **ROUTE**={TODEV | FROMDEV | BOTH}
 - TODEV
 - Displays the route through the fabric, starting with the channel and going to the device
 - FROMDEV
 - Displays the route through the fabric, starting with the device and going to the channel
 - BOTH
 - Displays the route through the fabric in both directions

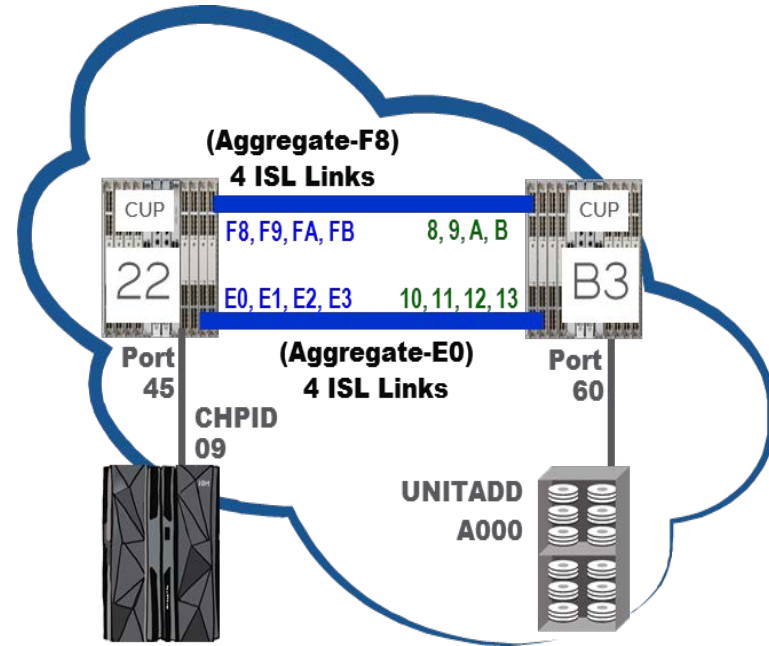
D M=DEV – Support for ROUTE / HEALTH

- z/OS MVS System Commands (SA22-7627)
- D M={DEVICE|DEV}(/ devnum,(chp))
 - **HEALTH**
 - Displays the health information, which includes the utilization, average delay, and error counts, for the fabric, switch, and port
- For a description of the display format, see message IEE583I
- Use Look At or use the MVS System Messages books

Brocade CUP Diagnostics and D M= command

Identify routing related issues and information about transceiver health

- Fundamental capability - FOS 7.1.0c and higher
- Enables ROUTE and HEALTH keywords on the Display Matrix (e.g. D M=) z/OS command.
- Proactively exposes information directly from the switch making fabric operations more visible to z/OS
- Flow Descriptions:
 - ROUTE=TODEV / FROMDEV
 - Show path through the fabric from channel to the device or device to the channel
 - HEALTH
 - Adds SFP power levels, transmit/receive utilization stats, and error counts to the report



CUP Diagnostics and D M= z/OS command

Command Output Example - Routing Information

Changes to the Display Matrix command (D M=DEV) describes the path through the fabric and the health of the fabric and its components.

```
D M=DEV(A000,(09)),ROUTE=TODEV,HEALTH
DEVICE 0A000 STATUS=ONLINE
```

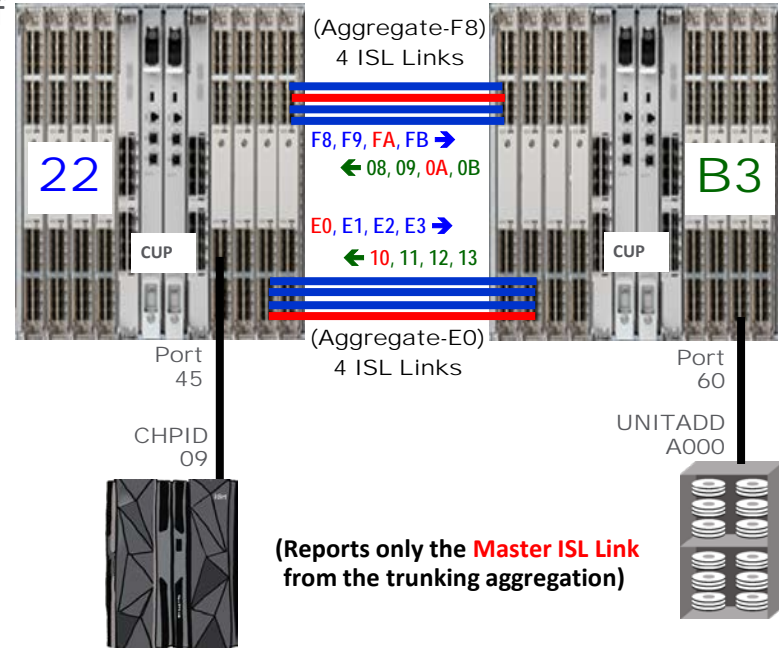
Source to destination routing information follows:

Switch Domain=22, Type=Source Director

Group							
Port	Type	From	To	Agg	Dyn	Speed	Misc
45	Entry	Chan	Agg-	FA ..	..	16G	Static
FA	Exit	A000	B30A	FA	..	16G	

Switch Domain=B3, Type=Destination Director

Group							
Port	Type	From	To	Agg	Dyn	Speed	Misc
0A	Entry	22FA	B360	FA	..	16G	Static
60	Exit	Agg-	CU	..	..	16G	.....





CUP Diagnostics Optical Signal

Command Output Example – Health Information

Health information follows:

Fabric Health=No health issues

Switch Domain=22, Health=No health issues

Port Health	%Util	%Delay	Error Count	Opt Signal
	Trn/Rcv	Trn/Rcv	Trn/Recv	Trn/Recv
45 Port Normal	99/99	0/0	0/0	-4.8/-6.6
FA Port Normal	99/99	4/0	0/0	-4.9/-6.6

Switch Domain=B3, Health=No health issues

Port Health	%Util	%Delay	Error Count	Opt Signal
	Trn/Rcv	Trn/Rcv	Trn/Recv	Trn/Recv
08 Port Normal	99/99	99/99	0/0	-2.5/ -3.8

CUP Diagnostics — Find Optical Signal Specs

Health information follows:

Fabric Health=**Port Error**

Switch Domain=22, Health=**BRD020-Port Error**

Port Health	%Util	%Delay	Error Count	Opt Signal
	Trn/Rcv	Trn/Rcv	Trn/Recv	Trn/Recv
45 BRP031-Bottleneck Detect	99/0	0/0	0/0	-4.8/-6.6
F8 No health issues	32/44	4/0	0/0	-4.9/-6.6
09 BRP030-Port Fenced	0/0	0/0	0/0	../-6.6
FA No health issues	32/44	4/0	0/0	-4.9/-6.6
FB No health issues	32/44	4/0	0/0	-4.9/-6.6



FMS Notification of a MAPS event at FOS 7.4+

A z/OS Health Checker and CUP Diagnostics Enhancement

- If configured, MAPS events get stored on the switch and CUP can access them:
 - Rules violations cause CUP to alert z/OS Health Check making these visible to z/OS.
- IBM Health Checker for z/OS handles CUP's unsolicited device interrupts and can then provide information to mainframe operations about whatever fabric issues have been identified:
- This enhanced zHealth Checker provides the user with information about those triggered MAPS events (i.e. a fenced port, etc.) and other useful data:
 - The content and format of this data is similar to the output of the D M=DEV command (described in [DISPLAY M=DEV command](#)) with the ROUTE=BOTH, HEALTH options.

IBM Health Checker for z/OS



IBM Health Checker for z/OS

- Objective: Identify potential problems before they impact your availability, or in worse cases, cause outages.
- Checks the current active z/OS and sysplex settings and definitions for a system and compares the values to those suggested by IBM, or defined by you.
- Not meant to be a diagnostic or monitoring tool, but a continuously running preventative that finds potential problems.
- Produces output in the form of detailed messages to let you know of both potential problems and suggested actions to take.

What is a check?

- A check is a program or routine that identifies potential problems before they impact your availability or cause outages.
- Checks analyze a configuration in the following ways:
 - Changes in settings or configuration values that occur dynamically over the life of an IPL.
 - Threshold levels approaching upper limits
 - Single points of failure in a configuration
- A check issues its output as messages (exceptions)

IBM Health Checker for z/OS and I/O

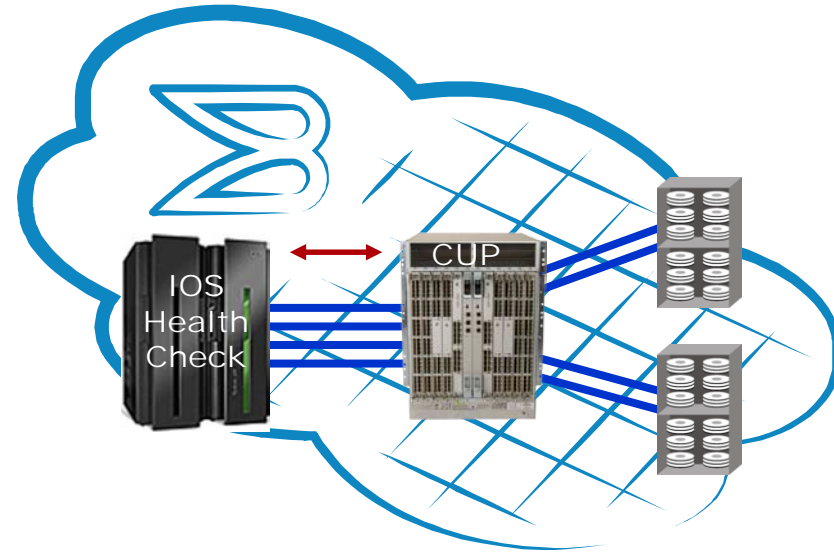
- Fabric Monitoring and Reporting utilizing CUP Diagnostics Alerts
 - The fabric monitor collects routing and health information from the switch periodically after it is triggered by one of the following unusual conditions:
 - Command response time monitoring or I/O rate time monitoring detected a discrepancy.
 - The switch presents an alert message indicating a problem within the fabric (MAPS alert)
 - An IFCC or interface time out occurs due to errors that occurred between the channel and source port or the CU and the destination port.

IBM Health Checker for z/OS and I/O

- Fabric monitoring and reporting can only occur when the channel is connected to a switch device and the control unit definition for the path is defined in the IODF with a two-byte link address.
- Until the route is healthy (no unusual conditions are detected for an extended period of time), diagnostic information about the affected source or destination route will be obtained from the switch by the monitor at an internally defined interval.
- Many routes can be monitored simultaneously.

IBM Health Checker for z/OS

- Health Checker is used to detect and monitor performance and RAS issues:
 - Within the CEC
 - Within the CEC's peripherals.
- The preponderance of I/O fabric operations are invisible to z/OS, which cannot quickly react to nor troubleshoot those issues
- CUP Diagnostics enables z Systems to receive direct alerts about fabric problem.
- Once a problem is identified, Health Checker can then proactively gather additional, detailed information about the fabric (e.g. components, topologies, ISL routing, and fabric problems)



Detecting previously invisible fabric issues and errors.

- Since IBM z/OS v1.7
- Since FOS v7.4.0a

Now Leverages CUP Diagnostics

IOS_CMRTIME_MONITOR

- Detects if any control units are reporting inconsistent average initial command response (CMR) time for their attached channel paths.
- Initial CMR time is a component of response time
 - measures the round trip delay of the fabric with minimal channel and control unit involvement
 - can be a symptom of potential problems in the FICON SAN fabric.
- By monitoring this measurement alone and comparing it among the paths to a CU, fabric issues like hardware errors, misconfiguration and congestion may be more easily detected.

IOS_CMRTIME_MONITOR

- The check issues an exception if at least one CU in the system has a path with an average CMR time that is the highest among the other paths to the CU and meets the following conditions:
 - Average CMR time for this path is greater than the THRESHOLD check parameter value.
 - Average CMR time for this path is significantly higher (defined by RATIO) than the path with the lowest average CMR time for this CU
- Let's look at an example

Example IOS_CMRTIME_MONITOR

- Path 1, average CMR time=11ms
- Path 2, average CMR time=3ms
- Path 3, average CMR time=2ms
- Path 4, average CMR time=4ms

- If THRESHOLD is 3ms and RATIO is 5, the check issues an exception because path 1 has a CMR time (11ms) > 3ms and is also 5x the CMR time for path 3 (2ms)

IOS_FABRIC_MONITOR

- Reports if any switches which support CUP diagnostic capabilities have indicated unusual health conditions on connected channel paths.
- When a switch determines that there is a performance problem with a path, it will signal to z/OS that such a problem has been found and diagnostic data is available.
 - Results in the route being monitored by z/OS and at regular intervals z/OS obtaining health diagnostic data.

IOS_FABRIC_MONITOR

- The fabric monitor health check (IOS_FABRIC_MONITOR) exposes possible issues by generating exceptions and reports for the routes being monitored.
- The routing and health data obtained by the monitor is reproduced in the report for analysis.
- The content and format of this data is similar to the output of the D M=DEV command (described in [DISPLAY M=DEV command](#)) with the ROUTE=BOTH, HEALTH options.
- See [IBM Health Checker for z/OS User's Guide](#) for more information about this health check.

Example- Port 08 on switch B3 is fenced

Example of how a Fenced Port in a fabric would be detected and reported

IOSHC120I Fabric Health Report

Page 1 of 2

The following channel paths **show fabric health issues:**

FABRIC HEALTH EXCEPTION DETECTED AT: 09/29/2015 14:31:18.301627

CHPID=09, Entry link=2245, Exit link=B310, Suspect port=**

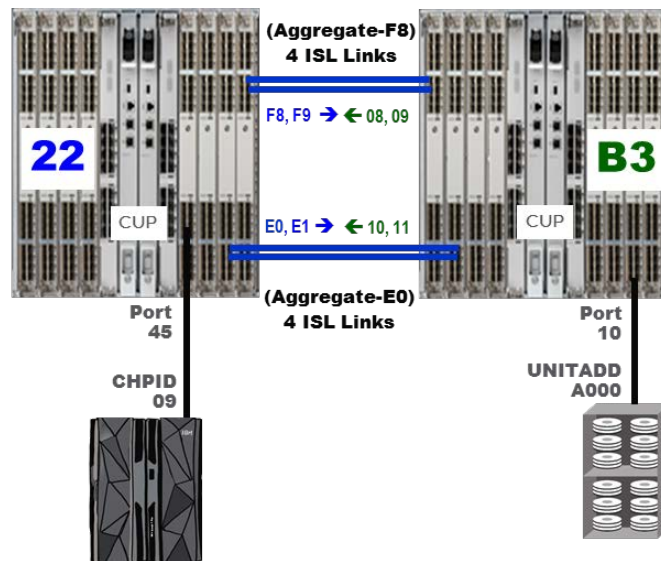
Source to destination routing information follows:

Switch Domain=22, Type=Source Director

Group							
Port	Type	From	To	Agg	Dyn	Speed	Misc
45	Entry	Chan	Agg	F8	..	16G	Dynamic
F8	Exit	A000	B308	F8	..	16G	
F9	Exit	A000	B309	F8	..	16G	

Switch Domain=B3, Type=Destination Director

Group							
Port	Type	From	To	Agg	Dyn	Speed	Misc
08	Entry	22F8	B310	F8	..	16G	
09	Entry	22F9	B310	F8	..	16G	
10	Exit	Mult	CU	..	..	16G	



IBM Health Checker for z/OS

Example of how a Fenced Port in a fabric would be detected and reported

Page 2 of 2

Health information follows:

Fabric Health=**Port Error**

Switch Domain=22, Health=**No health issues**

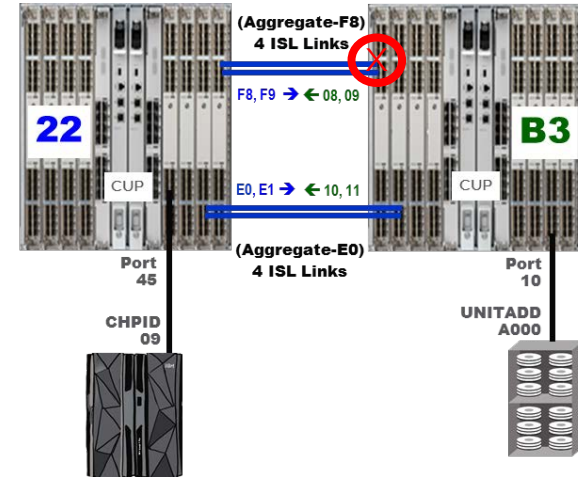
Port Health	%Util	%Delay	Error Count	Opt Signal
	Trn/Rcv	Trn/Rcv	Trn/Recv	Trn/Recv
45 Port Normal	0/0	0/0	0/0	-4.5/-7.4
F8 Port Normal	0/0	0/0	0/0	-2.4/-2.9
F9 Port Normal	0/0	0/0	0/0	-4.5/-7.4

Switch Domain=B3, Health=**Port error**

Port Health	%Util	%Delay	Error Count	Opt Signal
	Trn/Rcv	Trn/Rcv	Trn/Recv	Trn/Recv
08 Port Fenced	0/0	0/0	0/0	..-6.7
09 Port Normal	0/0	0/0	0/0	-2.4/-2.1
10 Port Normal	0/0	0/0	0/0	-4.5/-7.4

* Medium Severity Exception *

IOSHC119E Fabric health issues have been detected





CUP Diagnostics – Find Optical Signal Specs in MyBrocade

Command Output Example – Health Information – Found Problems

Health information follows:

Fabric Health=**Port Error**

Buffer Credits causing some slowdown as the adjacent port's receive BCs are all in use (Inconsistent I/O Elongation 8% of the time)

Switch Domain=22, Health=**BRD020-Port Error**

Port Health	%Util	%Delay	Error Count	Opt Signal
	Trn/Rcv	Trn/Rcv	Trn/Recv	Trn/Recv
45 BRP031-Bottleneck Detect	99/0	0/0	0/0	-4.8/-6.6
F8 No health issues	32/44	8/0	0/0	-4.9/-6.6
F9 BRP030-Port Fenced	0/0	0/0	0/0	../-6.6
FA No health issues	32/44	8/0	0/0	-4.9/-6.6
FB No health issues	32/44	8/0	0/0	-4.9/-6.6

Switch Domain=B3, Health=**No health issues**

Port Health	%Util	%Delay	Error Count	Opt Signal
	Trn/Rcv	Trn/Rcv	Trn/Recv	Trn/Recv
08 No health issues	44/32	0/8	0/0	-2.5/-3.8

New I/O Management Capabilities

Control Unit Alerting About Too Many Bit Errors

(SCU) (CHPID)

D M=DEV(D800,(52)),LINKINFO=LAST (Operator initiated action)

DEVICE 0D800 STATUS=ONLINE

Link Information: Last

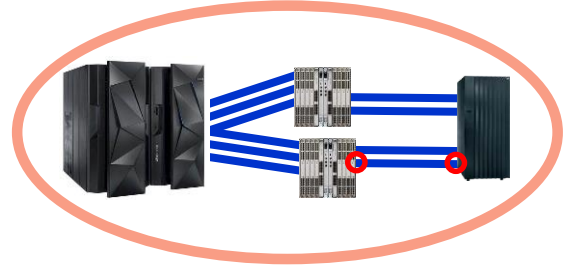
Description	Channel	Entry Port	Exit Port	Cntl Unit
Identifier	01F0	2E	29	0032
Date Retrieved	2/22/2017	02/22/2017	02/22/2017	02/04/2017
Time Retrieved	16:10:07	16:10:07	16:10:07	16:10:07
Tx Power (dBm)	0.8	-0.76	0.38	0.33
Rx Power (dBm)	-0.59	0.31	0.03	-8.53
Tx Bias (mA)	39.6	51.1	40.2	41.2
Temperature (C)	30.8	55	55	42.2
Capable Speed	16G	16G	16G	16G
Operating Speed	16G	16G	16G	16G
Buffer Credits	90	8	8	90
Link Failures	13	29	44	0
Loss of Sync	11	0	1	0
Loss of Signal	11	33	21	0
Primitive Seq Err	0	0	0	0
Invalid Trans word	876	1005	10021285	0
Invalid CRC	9	1693	0	0
FEC Uncorrected	1565	Not Avail	Not Avail	0



The problem is a failing SFP



The consequence was bit errors



Exit port on switch has a normal Tx power level (0.38), but the power on its receiver (Rx) control unit port was very low (-8.53)

That caused Invalid transmission words (ITW) which are frame bit errors which normally result from faulty SFPs, cables, etc.

(Reference the vendor SFP information provided in the notes on this slide)

Health Check Report

Health information follows:

Fabric Health=Port Error

Switch Domain=20, Health=No health issues

Port	Health	%Util Trn/Rcv	%Delay Trn/Rcv	Error Count Trn/Recv	Opt Sign Trn/Rec
00	Port Normal	1/0	0/0	0/0	+0.1/+0.2
01	Port Normal	2/3	0/0	0/0	+0.2/+0.2
02	Port Normal	0/0	0/0	0/0	+0.2/+0.4
03	Port Normal	0/1	0/0	0/0	+0.4/+0.7
04	Port Normal	2/1	0/0	0/0	+0.2/+0.1

Switch Domain=30, Health=Port Error

Port	Health	%Util Trn/Rcv	%Delay Trn/Rcv	Error Count Trn/Recv	Opt Sign Trn/Rec
10	High Error Count	2/2	0/0	93/26	+0.9/+0.8
11	Port Normal	0/0	0/0	0/0	+0.2/+0.2
12	Port Normal	1/0	0/0	0/0	+0.2/+0.4
13	Port Normal	1/2	0/0	0/0	+0.4/+0.7
18	Port Normal	0/0	0/0	0/0	+0.2/+0.1

z/OS Health Checker

Fabric Monitoring and Reporting utilizing CUP Diagnostics Alerts

Policy	Rule Name	Condition	Actions
Agressive	defALL_HOST_PORTSC3TXTO_2	ALL_HOST_PORTS(C3TXTO/MIN>2)	RASLOG,SNMP,EMAIL, FMS
	defALL_HOST_PORTSC3TXTO_4	ALL_HOST_PORTS(C3TXTO/MIN>4)	FENCE,DECOM,SNMP,EMAIL, FMS
	defALL_OTHER_F_PORTSC3TXTO_2	ALL_OTHER_F_PORTS(C3TXTO/MIN>2)	RASLOG,SNMP,EMAIL, FMS
	defALL_OTHER_F_PORTSC3TXTO_4	ALL_OTHER_F_PORTS(C3TXTO/MIN>4)	FENCE,DECOM,SNMP,EMAIL, FMS
	defALL_BE_PORTSCRC_5M_10	ALL_BE_PORTS(CRC/5MIN>10)	RASLOG,SNMP,EMAIL, FMS
	defALL_BE_PORTSCRC_D_100	ALL_BE_PORTS(CRC/DAY>100)	RASLOG,SNMP,EMAIL, FMS
	defALL_BE_PORTSITW_5M_10	ALL_BE_PORTS(ITW/5MIN>10)	RASLOG,SNMP,EMAIL, FMS
	defALL_BE_PORTSITW_D_100	ALL_BE_PORTS(ITW/DAY>100)	RASLOG,SNMP,EMAIL, FMS
	defALL_BE_PORTSLR_5M_10	ALL_BE_PORTS(LR/5MIN>10)	RASLOG,SNMP,EMAIL, FMS
	defALL_BE_PORTSLR_D_100	ALL_BE_PORTS(LR/DAY>100)	RASLOG,SNMP,EMAIL, FMS
	defALL_BE_PORTSBAD_OS_5M_10	ALL_BE_PORTS(BAD_OS/5MIN>10)	RASLOG,SNMP,EMAIL, FMS
	defALL_BE_PORTSBAD_OS_D_100	ALL_BE_PORTS(BAD_OS/DAY>100)	RASLOG,SNMP,EMAIL, FMS
	defALL_BE_PORTSFRM_LONG_5M_10	ALL_BE_PORTS(FRM_LONG/5MIN>10)	RASLOG,SNMP,EMAIL, FMS
	defALL_BE_PORTSFRM_LONG_D_100	ALL_BE_PORTS(FRM_LONG/DAY>100)	RASLOG,SNMP,EMAIL, FMS
	defALL_BE_PORTSFRM_TRUNC_5M_10	ALL_BE_PORTS(FRM_TRUNC/5MIN>10)	RASLOG,SNMP,EMAIL, FMS
	defALL_BE_PORTS_FRM_TRUNC_D_100	ALL_BE_PORTS(FRM_TRUNC/DAY>100)	RASLOG,SNMP,EMAIL, FMS

- Here is an example of the MAPS events that can be monitored
- **FMS** as an action brings into play CUP Diagnostics